1   **MOBILE DEVICE AND DISK DRIVE RESTRICTED FROM READING A DATA**

2   **STORAGE ZONE IN A MOBILE ENVIRONMENT**

3   **BACKGROUND OF THE INVENTION**

4   **Field of the Invention**

5   The present invention relates to digital data storage, and more particularly, to a hard disk

6   drive for use in a mobile device.

7   **Description of the Prior Art**

8   A hard disk drive provides digital data storage on a magnetic media that is accessed using

9   a flying head that precisely floats over the media. Use of a hard disk drive in a hand-held

10   portable device is generally problematic because the device may be subjected to fairly high shock

11   levels. A shock delivered to the disk drive may cause the head to contact or "slap" the disk

12   media surface or cause the head to move off track and damage adjacent track data during a write

13   operation.

14   Accordingly, there exists a need for a relatively rugged disk drive for use in a mobile

15   device. The present invention satisfies these needs.

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17   **SUMMARY OF THE INVENTION**

18   The present invention may be embodied in a disk drive for use in a mobile device. The

19   mobile device includes a host processor that accesses data on the disk drive. The disk drive has a

20   rotating disk media and a moveable read/write head disposed over the disk media. The disk

21   media is divided into first and second data zones that are radially disposed in discrete areas of the

22   disk media and that each has a plurality of tracks for storing data. The mobile device may read

23   data from the first data storage zone when the mobile device is in a mobile environment. The

24   mobile device may read data from the second data storage zone only when the mobile device is

25   in a non-mobile environment and may not read data from the second data storage zone when the

26   mobile device is in a mobile environment.

27   In more detailed features of the invention, the mobile device is in a non-mobile

28   environment when the mobile device is placed in a docking station and the mobile device is in a

29   mobile environment when the mobile device is not placed in a docking station. The first data

1   storage zone may include a mobile-safe zone, a mobile-normal zone, and a docked-safe zone.

2   The second data storage zone may include an ultra-safe zone. The mobile device may write data

3   to the ultra-safe zone or the docked-safe zone only when the mobile device is in a non-mobile

4   environment, and may write data to the mobile-safe zone or to the mobile-normal zone when the

5   mobile device is in a mobile environment or is in a non-mobile environment. The disk drive may

6   prevent the moveable read/write head from dwelling or moving over the ultra-safe zone when the

7   device is in a mobile environment. The mobile-safe zone may have a track pitch that is wider

8   than a track pitch of the mobile-normal zone, the docked-safe zone, and/or the ultra-safe zone.

9   In other more detailed features of the invention, the disk drive includes a ramp for

10   parking an actuator arm coupled to the read/write head when the disk drive is in a spin-down

11   mode. The disk drive may include a mobile-low-power zone that is located on the disk media so

12   that an actuator current is minimized for moving the read/write head to a data track in the

13   mobile-low-power zone upon loading of the read/write head over the disk media from the ramp.

14   A distance from an outer diameter of the disk media to the mobile-low-power zone may be

15   between about 10 and 15 percent of a distance between the outer diameter and an inner diameter

16   of the disk media.

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18   **BRIEF DESCRIPTION OF THE DRAWINGS**

19   The accompanying drawings illustrate embodiments of the present invention and,

20   together with the description, serve to explain the principles of the invention.

21   FIG. 1 is a block diagram of a mobile device having a disk drive with a data storage zone

22   that is restricted from reading while the device is in a mobile environment, according to the

23   present invention.

24   FIG. 2 is a block diagram showing a mobile device having a restricted-zone disk drive

25   according to the present invention, placed in a docking station that provides a non-mobile

26   environment for the mobile device.

27   FIG. 3 is a block diagram showing a mobile device having a restricted zone disk drive

28   according to the present invention, in a mobile environment removed from the docking station.

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DETAILED DESCRIPTION

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2   With reference to FIG. 1, the present invention may be embodied in a disk drive 10 for

3 use in a mobile device 12. The mobile device may be a hand held computing device such as a

4 personal digital assistant (PDA) or a mobile terminal such as a cellular telephone. The mobile

5 device includes a host processor 14 for accessing data on the disk drive. The disk drive 10 has a

6 rotating disk media 16 and a moveable read/write head 18 disposed over the disk media. The

7 disk media is divided into a first data storage zone, 20, 22, 24, and a second data storage zone,

8 26. The data storage zones are radially disposed in discrete areas of the disk media and each

9 zone has a plurality of tracks for storing data. The mobile device may read data from the first

10 data storage zone when the mobile device is in a mobile environment. The mobile device may

11 read data from the second data storage zone only when the mobile device is in a non-mobile

12 environment and may not read data from the second data storage zone when the mobile device is

13 in a mobile environment.

14   Enforcement of rules for accessing data storage zones according to whether the mobile

15 device 12 and disk drive 10 are in a mobile environment can be implemented in a program

16 executed by the mobile device host processor14, by a program executed by a disk drive

17 microprocessor within disk control system 36, or by a combination of both. For example, the

18 disk drive 10 can be manufactured with a program which defines rules for mobile access of

19 specific zones, and the host program can inform the disk drive of whether the environment is

20 mobile or not. This could be determined by a signal from a docking station 28 (FIG. 2 below) to

21 the mobile device 12, or by monitoring a signal indicating the presence of AC power. In another

22 embodiment, the signal can be detected by logic within the disk drive 10.

23   With reference to FIGS. 2 and 3, the mobile device is in a non-mobile environment when

24 the mobile device 12 is placed in a docking station 28 (FIG. 2) and is in a mobile environment

25 when the mobile device is removed from the docking station (FIG. 3). The mobile environment

26 can be harsh on the mobile device subjecting it to fairly high shock levels. These high shock

27 levels may affect the integrity of the data stored on the disk drive. Accordingly, data requiring a

28 higher level of integrity may be stored in the second data storage zone and may be read only

29 when the device is docked for charging, data transfer, or synchronization with a stationary

30 computer 30 or with another computing device.

1   The first data storage zone may include a mobile-safe zone 22, a mobile-normal zone 20,

2   and a docked safe zone 24. The mobile-safe zone may have a track pitch that is wider than a

3   track pitch of the mobile-normal zone, the docked safe zone, and/or the second data storage zone.

4   The second data storage zone may include an ultra-safe zone 26. The mobile device 12

5   may read data from the ultra-safe zone only when the mobile device is in a non-mobile

6   environment and not when the mobile device is in a mobile environment. The disk drive 10 may

7   prevent the moveable read/write head from dwelling or moving over the ultra-safe zone when the

8   device is in a mobile environment. The ultra-safe zone and the docked-safe zone 24 of the first

9   data storage zone may be separated by a gap.

10   The mobile device 12 may write data to the ultra-safe zone 26 or to the docked safe zone

11   24 only when the mobile device is in a non-mobile environment and not when the mobile device

12   is in a mobile environment. The mobile device may write data to the mobile-normal zone 20 and

13   the mobile-safe zone 22 when the mobile device is in a mobile environment or when the mobile

14   device is in a non-mobile environment.

15   The disk drive 10 includes a ramp 32 for parking an actuator arm 34 coupled to the

16   read/write head 18 when the disk drive is in a spin-down mode. The disk drive may include a

17   mobile-low-power zone 36 that is located on the disk media such that an actuator current is

18   minimized for moving the read/write head to a data track in the mobile-low-power zone upon

19   loading of the read/write head over the disk media 16 from the ramp. The mobile-low-power

20   zone may have data read from but may not have data written to it when the mobile device is in a

21   mobile environment. A distance from an outer diameter of the disk media to the mobile-low-

22   power zone is between about 10 and 15 percent of a distance between the outer diameter and an

23   inner diameter of the disk media.

24   The disk drive 30 includes a disk control system 36 and a head disk assembly (HDA) 38.

25   The HDA includes a magnetic disk having the disk media 16 with the plurality of concentric data

26   tracks recorded thereon, the head 18 for writing user data to or reading user data from a selected

27   one of the data tracks in response to host command during a user operation of the disk drive, and

28   an actuator 42 for positioning the head over the selected track. The head 18 in present disk

29   drives comprises a giant magneto-resistive (GMR) read element and thin film inductive write

30   element. The actuator is typically implemented as a voice coil motor (VCM) which rotates the

1   actuator arm 34 about a pivot 44 in order to position the head radially over the disk in response to

2   control signals from the disk control system. The HDA 44 also includes a preamplifier 46 and a

3   spindle motor 48 for rotating the disk. The head communicates with the disk control system via

4   the preamplifier. The disk control system also includes circuitry and processors that provide an

5   intelligent disk control system interface between the host processor 14 and the HDA for

6   execution of read and write commands.

7   The disk control system 36 implements a servo control loop which causes the head 18 to

8   follow a centerline of the selected track in an operation generally referred to as "track following."

9   During track following, the path of the head wanders about a track centerline. Typically, the disk

10   control system attempts to limit the head wander to within a predetermined range defined by a

11   "Track Misregistration" (TMR) budget.

12   In accordance with a wider track pitch in the mobile-safe zone 22, a servo control system

13   in the disk drive 10 may modify certain parameters of its servo algorithms such as adjusting the

14   granularity of analog to digital conversions for servo burst patterns to reflect the track spacing, or

15   employing a larger "write unsafe" limit that allows the disk drive to more safely and successfully

16   write data while the device 12 in the mobile environment. . The varied track pitches may be

17   accomplished using a disk drive disclosed in U.S. Patent No. 6,052,250 titled DISK DRIVE

18   WITH SEPARATELY DETERMINED SERVO AND DATA TRACK PITCH. U.S Patent No.

19   6,050,250 is incorporated herein in its entirety by reference.

20   Alternatively, the mobile device 12 may skip tracks in the mobile-safe zone 22 and use

21   the larger write unsafe limit to allow the disk drive 10 to more safely write data when in the

22   mobile environment. The skipping of data tracks may be accomplished using a technique

23   disclosed in U.S. Patent No. _____ [Application serial No. 09/728,627 filed 11/30/2000] titled

24   METHOD FOR MINIMIZING ADJACENT TRACK DATA LOSS DURING A WRITE

25   OPERATION IN A DISK DRIVE. U.S. Patent No. _____ [Application serial No.

26   09/728,627] is incorporated herein in its entirety by reference.

27   It is contemplated that the ultra-safe zone 26 may be relatively small for holding very

28   secure data such as passwords or the like. The data in the ultra-safe zone may be mirrored in the

29   mobile-readable zones for mobile access. The docked-safe zone 24 may be a medium-sized zone

30   for data requiring a relatively high integrity such as schedules, presentations, etc. If changes to

1   data in a docked-safe zone are required in a mobile environment, a copy may be made in a

2   mobile zone, and changed accordingly. When the device is docked, the docked-safe copy may

3   be updated and the mobile copy deleted. The mobile-safe zone 22 may be a small-sized zone for

4   holding relatively high integrity data that can be used to update the docked-safe zone when the

5   device is docked. The mobile normal zone 20 may be a large-sized zone for holding data of

6   relatively low important such as data from games or web surfing. The low-power zone 36 may

7   be a small-sized zone for storing data requiring a low amount of energy to access.